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and the differences of these give

$$62921m-140278l+186603=0$$
$$105075m-240476l+330454=0.$$

Again dividing by the leading coefficients,

$$m-2{\cdot}22943l+2{\cdot}96567=0$$
$$m-2{\cdot}28861l+3{\cdot}14494=0$$

the difference of which gives

$$5918l-17927=0$$
$$\therefore\ l=3{\cdot}02923$$
$$m=3{\cdot}78779$$
$$n=1{\cdot}68664.$$

Hence we find that α, β, γ, are the roots of the cubic equations

$$x^3-3{\cdot}02923x^2+3{\cdot}78779x-1{\cdot}68664=0.$$

One root of this equation is ·903017, and, by dividing by $x-{\cdot}903017$, the depressed equation containing the other two roots is

$$x^2-2{\cdot}12621x+1{\cdot}86778=0,$$

and these roots are therefore imaginary. It follows, that the condition of least squares cannot be fulfilled by real numbers, with reference to the Carlisle table.

On the Influence of Railway Travelling on Public Health. By H. W. Porter, B.A.

The investigation of the different causes that tend to influence the health of the community, either injuriously or otherwise, is one of great public importance, particularly in a high-pressure age like the present—an age in which it is too much the custom to sacrifice all considerations of health and safety to a determined and eager desire to do in a few hours what our ancestors were content to do in as many days.

The present remarks are due to the perusal of a most interesting and valuable series of papers recently published in the *Lancet*, and subsequently issued in a separate form.*

These papers are the result of a scientific commission organized by the proprietors of the *Lancet*—a medical periodical which has done good service to the cause of sanitary reform, no less than to that of medical and surgical progress—with the express object of inquiring into the influence of railway travelling on health.

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* "The Influence of Railway Travelling on Public Health." From the *Lancet*. London: Robert Hardwicke, 192, Piccadilly.

This periodical, some years ago, originated a commission, which undertook the analysis of the principle articles of food. The result of this was, that the attention of the public was directed to the alarming and pernicious extent to which the adulteration of the different articles of everyday food was being carried on by ignorant and unprincipled tradesmen, to the detriment no less of the constitutions than of the purses of the unhappy consumers.

To the *Lancet* we owe the tardy concession on the part of the Government of some legislative enactments of sufficient power, let us hope, to remedy to a considerable extent the evils so long complained of, in the passing of the Adulteration of Food Act, and the appointment of professional analysts in connection therewith.

To Life Assurance Companies all investigations that have for their object the improvement of the health, and in consequence the longevity of the people, are clearly of no mean importance, and in this relation therefore it is conceived the present subject is one which will not prove uninteresting to the readers of the *Assurance Magazine.*

Medical men are very generally agreed, that in spite of the advance of knowledge, and of the improved methods of medical practice founded thereon, certain classes of diseases, particularly those affecting the brain, are far from diminishing, and the demand for space in our lunatic asylums is, it is understood, increasing in a greater ratio than the increase of population would seem to warrant.

This is, no doubt, due to several causes, but it is probably not unreasonable to consider, that, to some extent at least, the facts just stated may be due to the now universal rapid locomotion, the facilities for which have of late years been so much increased, as the papers now referred to would appear to show.

The editors of the *Lancet* have been for some time past engaged in collecting evidence from the most eminent physicians and surgeons of the day—some of whom, from the opportunities at their command of seeing a particular class of practice, are peculiarly competent to give their opinions on the subject.

The different gentlemen referred to, moreover, have each contributed the result of their respective inquiries and experience in respect of the effect produced by railway travelling in developing or increasing those very diseases the study of which they have made their particular specialty.

Thus, Dr. C. J. B. Williams, F.R.S.—a physician most eminent for his perfect acquaintance with diseases of the lungs and organs of respiration—furnishes his evidence as to the effect of railway locomotion upon persons suffering from, or predisposed to, diseases of the chest.

Dr. Brown-Séquard, Dr. Radcliffe, Sir Ranald Martin, K.C.B., F.R.S., and Mr. Ernest Hart, have been consulted as to the effect in cases of cerebral disease, and affections of the nervous system, apoplexy, spinal anæsthesia, and diseases of the vertebral column; Mr. White Cooper, in relation to the sight; Dr. Waller Lewis, as to the injurious influence in causing a retention of the secretions, and consequent complaints of the bladder and kidneys, as well as to its effect in the production and increase of disease generally—in regard to which this gentleman, from his position of physician to the Post Office authorities, is likely, from his necessarily great experience, to be particularly well informed.

Dr. G. Hewitt and Dr. Meadows have investigated the matter in connection with pregnancy; Mr. Harvey, its effect in producing diseases affecting the ear and throat, resulting in deafness and neuralgia, and even in paralysis of the facial nerve. Mr. Wm. Adams speaks as to the influence of railway locomotion on persons affected with diseases of the vertebral column; and Mr. Hilton in reference to the dangers arising from retention of the secretions.

Dr. Angus Smith has experimented with reference to ventilation and temperature; and several of these gentlemen have, in addition, testified as to the influence of railway travelling in causing dyspepsia, derangements of the liver, and diseases of the abdominal viscera.

In the present remarks the question of accidents producing death or bodily mutilation, caused by collisions and other similar means, is not considered. It may be sufficient to state that the number of deaths from such causes is probably very small in comparison with the fatalities arising from diseases engendered and fostered by rapid and persistent railway locomotion, among persons to whom that mode of transit happens to be, from constitutional reasons or otherwise, peculiarly obnoxious.

From the evidence now made public, there would appear to be no question whatever that an alarming amount of mischief is produced by this new system, on which we are all so dependent, *new,* for so recently as the year 1825 there was but one railway carriage for the conveyance of passengers in the world—on the Stockton and Darlington Railway. In considering a question of this kind, it is most difficult to arrive at any exact determination as to the extent to which the evil complained of is carried, owing to the necessary and invariable confusion between the *post hoc* and *propter hoc.*

It is easy to determine that a certain amount of injurious effect has been produced among habitual travellers on railways, but quite impossible to decide in how many cases the same diseases would have been developed had railway travelling never been resorted to. In fact, our information on the subject is, as yet, very limited indeed, the inquiry which forms the subject of the present article being the first attempt at arriving at any determination on the question.

The following tables by Mr. Finlaison, the Government actuary, are referred to as showing the high percentage of sickness among railway officials, in comparison with other classes of persons :—

Number of Sick Persons out of each 100 *liable to Sickness.*

Age.	England and Wales.	ORDINARY HEAVY LABOUR.		Mariners.	Miners.	Railway Officials.
		Without Exposure.	With Exposure.			
20	26·62	26·47	28·69	16·89	23·23	31·00
25	23·94	25·10	26·47	15·61	20·90	33·06
30	22·57	23·45	25·74	17·96	28·65	33·94
35	22·38	24·00	25·64	18·86	32·50	34·11
40	23·26	24·34	27·01	17·89	28·92	32·23
45	24·11	25·14	28·14	20·51	37·56	32·10
50	26·00	28·10	29·34	22·27	36·87	30·43
60	31·07	33·25	35·42	28·00	58·62	41·76

Average Amount of Sickness per Annum to each Person, in Days.

Age.	England and Wales.	HEAVY LABOUR.		Mariners.	Railway Officials.
		Without Exposure.	With Exposure.		
20	6·88	6·71	7·16	5·24	8·00
25	6·83	6·82	7·45	5·21	8·63
30	6·91	7·06	7·69	6·59	9·93
35	7·14	7·45	8·04	9·02	8·89
40	8·21	8·03	9·40	7·99	10·91
45	9·34	9·87	10·78	11·41	12·15
50	11·49	12·15	12·58	13·41	15·23
60	18·73	20·36	21·78	24·55	15·45

In the foregoing tables all classes of railway servants are included.

Travelling servants are, no doubt, liable to an even higher rate of sickness, as may be inferred from the following extract :—

> "The result of inquiries carried on amongst the travelling servants of all the great Companies has been to convince us that only picked individuals are fitted for the service, and that it is amongst these picked lives that the above high rates of sickness prevail. To be able to endure the fatigue of the travelling service, a man must not only be of perfectly sound and healthy constitution, but he must begin *young*. It was stated to us on all hands that men over thirty or thirty-five find themselves unable to acquire a tolerance of the bodily and cerebral fatigue involved in the duties, and that, after considerable experience on this head, the Companies have found it necessary to limit their engagements to young and healthy men."

In the year 1859, Dr. Waller Lewis, the chief medical officer to the Post Office, undertook an investigation into the health of the various officials employed in the railway post office. He observed those persons in the performance of their duties, and inquired minutely into the state of their health before they entered upon that service. The total number under observation was 300.

The average length of the journeys of the clerks and sorters is stated to be about 170 miles.

The average time occupied in the journey is about 5½ hours.

The highest speed attained is 44 miles an hour—stoppages included.

The average speed was not ascertained.

On night mails the clerks and sorters have usually two days' rest in eight; the mail guards two days' rest in six.

On day mails a less proportion of rest is considered sufficient.

Dr. Lewis reports that he found, *cæteris paribus*, tall persons, of full habit of body, to be much less fit for these travelling duties than more wiry individuals; that those who commence those duties after the age of 25 are less able to endure them continuously than those who begin earlier; that narrow-gauge lines exert a greater injurious influence than the broad-gauge; and that the greater the speed the worse the effects.

The influence on healthy persons is much less than upon those who possess weak constitutions; indeed, to some persons, railway travelling would appear to be even beneficial.

It is shown, however, that even perfectly healthy persons are injuriously affected, if their habits are irregular, or if they fail to take a due amount of rest.

The ill effects experienced by weakly persons are stated to depend upon the peculiarities of their constitutions, and on their state of health generally.

Phthisis, whether in the first or second stage, as well as diseases of the heart, are considered to incapacitate for railway locomotion.

Persons of a nervous temperament seem to be peculiarly obnoxious to this mode of transit. They are likely to suffer from paralytic seizures.

The mischievous effects of allowing the eyes to rest upon external objects, *near at hand*—such as telegraph posts and wires, near trees, hedges, &c.—is strongly dwelt upon.

The after effects of collisions, though there may be no apparent injury at the time of the accident, are shown to be frequently highly injurious, even when not fatal.

Injuries of this kind usually arise from concussion of the head, spine, or nervous system. These after effects may not be experienced for some weeks, when headache begins to be felt, coma supervenes, and death, from serous effusion on the brain, takes place.

Complete rest, after such accidents, is imperative, whether any inconvenience be felt at the time or not.

Owing to the great difficulty of regulating the ventilation and temperature of railway carriages, persons suffering from diseases of the lungs are found to be most injuriously affected; the dust, draughts of air, and extremes of temperature incidental to railway travelling—particularly in the post-office carriages—being very great.

It is satisfactory to find, from the Report of Dr. Lewis, that due attention is paid to any suggestions that may be made with the view to remedy the evils necessarily inherent to the duties of the travelling post-office officials. Elastic caoutchouc mats are found to intercept vibration; double roofs to the carriages have, in some cases, been introduced, with the view to equalize the temperature, and to lessen the noise produced by the motion of the trains, particularly in tunnels. With the view to diminish the risk of injury in cases of collision, the sharp angles of the woodwork in the postal carriages are all rounded off; the hard portions of the internal fittings are well padded with cushions; and other similar precautions are taken, as experience suggests.

Dr. Lewis concludes his Report, with certain suggestions for the improvement of railway carriages, no doubt highly valuable, but which are of too practical a nature for us to quote.

One of his conclusions, however, would appear to be much at variance with what might naturally have been expected to be the case, as the following extract seems to show:—

> "I am much inclined to believe that those who travel only occasionally, at uncertain intervals, or even as frequently as four or five times a week, are

more obnoxious to the effects of railway travelling than those who, like our own officers, or the *employés* on railways, make it the special business of their lives. The constitutions and bodies of the latter seem to adapt themselves to the circumstances."

On the whole, Dr. Waller Lewis appears to be of opinion that "our experience of railway travelling is not sufficiently great to enable any person to state positively the *ultimate effects* of this new habit on the constitutions or health of the mass of people who thus travel."

Dr. Lewis, it will be seen, has, for the most part, confined his attention to the travelling post-office officials. We shall now see what the apparent effect of railway travelling is likely to be upon the general public.

In considering a question of this kind, it is necessary to proceed with great caution, if we wish to deduce true results from the facts before us, because, in the words of the *Lancet* Commissioners—

> . . . "the effects are of subtle and complicated character, and because habitual railway travellers are subject to many various disturbing causes in their other relations of life, to which no cognizance is given. It is, therefore, essential to have some means of correcting even actual experience, by a rational investigation into the causes, character, and extent of the symptoms induced. There can be no doubt, that hitherto many ailments have been credited to this cause which had a very different origin. On the other hand, there is reason to believe that many persons have treated the effects produced with undue carelessness, and, not being sufficiently on their guard, have suffered from persistence in a habit injurious to them.
>
> "But in place of the many vague surmises heretofore hazarded on this subject, we can now substitute accurate information as to the direct physical effects of railway travelling upon the body. These are, to produce a certain degree of muscular exertion; to increase the volume of air inspired; to quicken the circulation; to impress rapidly on the retina a succession of fleeting images; and to cause more or less increased afflux of blood to the brain and spinal cord, and some irritation of the gastric and sympathetic nerves by means of the vibratory movements of the body. Bearing in mind this general analysis of the effect of railway travelling, and giving due consideration to the circumstances which modify them, it becomes possible to estimate at their true value the complaints as to the various illnesses and diseases which have been ascribed to it. In no case is it more desirable to test, one by the other, clinical experience and physiological observation."

It would, of course, be out of place in this *Magazine* to give the details of the cases quoted by the different medical men examined by the *Lancet* Commissioners, in confirmation of their opinions as to the production of disease by railway travelling.

The following quotations of one series of cases are, however, of interest. They came under the notice of Dr. Radcliffe, and are important, from the fact that no other treatment was adopted than the cessation of railway travelling, while the symptoms recurred immediately on the patients resuming the practice—showing clearly the true cause of the mischief:—

"*Cases of Affection of the Nervous System. By Dr. Radcliffe.*

"A hale and stout gentleman, aged 63, came to me, complaining of inability to sleep, numbness in the limbs, great depression, and all the symptoms of approaching paralytic seizure. He was very actively engaged in large monetary transactions, which were naturally a source of anxiety. He had a house in town; but, having been advised by the late Dr. Todd to live at Brighton, he had taken a house there, and travelled to and fro daily by the express train. The symptoms of which he complained began to appear about four months after taking up his residence at Brighton, and he had undergone a variety of treatment without benefit, and was just hesitating about trying homœopathy, when I saw him. I advised him to give up the journeys for a month, and to make the experiment of living quietly in town. In a fortnight his rest was perfectly restored, and the other symptoms rapidly disappeared, so that at the end of the month he was as well as ever again. After three months he was persuaded to join his family at Brighton again, and resumed his daily journeys. In a few days his rest became broken, and in two months all the old symptoms returned. By giving up the journeys and residing in town he was again perfectly restored; but it being the end of the season, when the house at Brighton could not be readily disposed of, and yielding to the wishes of his family, he again resumed his journeys. In a month's time he was rendered so seriously unwell, that he hesitated no longer in taking up his permanent residence in town; and since this time (now more than two years ago) he has enjoyed perfect health.

"A barrister in large practice, about 50 years of age, had a house about 20 miles from town, and travelled daily to and fro by rail. He complained that he found he was incapacitated for work on arriving in the morning, and that he was unable to bring his mind to bear properly on a subject until he had lunch, when the effect of the journey seemed to wear off; and that after the return journey he was unable to sleep, or did so but slightly. He tried various plans—walking in the country, riding, &c.—all of which only made him worse, and increased the feeling of *malaise*. Bearing in mind the former case, I strongly urged him to sleep in town for a time, and with the best results, for he found that his night's rest was restored, and that his intellect was as bright in the morning as it had formerly been. After some weeks, considering himself quite well, the country journeys were resumed, and with them the old troubles. In a month, indeed, all the old symptoms returned, and he was forced to relinquish his country residence. Since this time (more than twelve months ago) he has had no cause of complaint."

The following is an interesting case of evidently nervous affection of the heart, which was mistaken for serous disease of that organ, but which was rapidly relieved by the patient's giving up the practice which had produced his discomfort—the daily journey by rail, in this instance only over a short distance. For this case we are also indebted to Dr. Radcliffe:—

"A gentleman, aged 34, holding an important Government appointment, took a house about 14 miles away from the scene of his daily duties. After a few months, he suffered from palpitations, pain about the region of the heart, and a general feeling of anxiety. For this he consulted an eminent physician, who diagnosed serious organic mischief. This naturally distressed the patient considerably, and he was on the point of throwing up his appointment, when, coming to me, I suggested that he should try the effect of giving up his short daily journeys before taking so important a step. This was done; he was rapidly restored to health, and he has since had no indication of cardiac mischief."

Numerous other cases are given—comprising cases of cerebral disease, epilepsy, spinal anæsthesia, affections of the bladder and kidneys, and cases of abortion and hæmorrhage, which occurred in the practice of Mr. J. Sharpe, Dr. Brown-Séquard, Dr. Anthony, Mr. Ernest Hart, Dr. W. Lewis, and Dr. Meadows—all which serve to show the injurious effect of railway travelling on some constitutions.

In addition to the quotation of actual cases, of which the details are given in full, the opinions of several eminent medical men have been elicited, in relation to other diseases, as previously mentioned.

Dr. C. J. B. Williams enters into the question of the noise and shaking motion of railways, as producing bodily and mental fatigue in long journeys. He points out how much the evils exhibited in this respect are under control; and his remarks are so valuable, as indicating to the railway authorities in what way they might endeavour to diminish the serious evils well known to exist, that we extract them in full:—

"*Noise and Shaking Motion of Railways. By Dr. C. J. B. Williams.*

"The bodily and mental fatigue induced by long journeys is mainly referable to the shaking and noise; and the indisputable fact that these operate more strongly in second and third class carriages than in first, at once indicates that they admit of considerable mitigation, if not of prevention. In fact, no one can have much experience in railway travelling without observing an extraordinary difference in the amount of noise and motion in trains on different lines. According to my experience, I would name as the smoothest and quietest of the great metropolitan lines, the Great Northern, the North-Western (except in certain parts), and the Great Western (except also in certain parts, and except in the too common case of neglect in closely coupling the carriages). For noisiness, the Brighton line certainly carries off the palm, perhaps from the number and length of its tunnels and deep cuttings; but for *shakiness*, the South-Eastern express trains have the pre-eminence, being only now and then equalled by the last ill-coupled carriages of a Great Western express train.

"Now, these examples further suggest the inference, that if some railway lines are more shaky and noisy than others, this must be due to some defect in the construction of the line or of the carriages, or of both; and that if some trains on the same line have more motion and noise than others, it must be from something wrong in the carriages themselves; and, as already hinted, one great fault is in the loose and careless manner in which the carriages are coupled together. That such easily preventable causes of injury and disturbance ought to be removed, is very obvious; and if railway directors and managers cannot be persuaded to enforce on their servants a due attention to this matter for the sake of the comfort and welfare of the passengers, perhaps they may be removed by the consideration that the shaking which wearies and bruises living bodies, also strains and wears unduly the rolling stock, and thus will add not only to the working expenses, but likewise to the risk of *costly* accidents. Any one well acquainted with the principles of mechanics and acoustics will scarcely fail to perceive that much improvement is possible in the construction of railway carriages, with the objects of diminishing their superfluous movement and noise.

"The shaking motion of a railway carriage is commonly most felt in the back, loins, waist, and head; but any limb or part tender from disease is likely to suffer from it. The noise obviously most affects the head, and it adds much to the suffering and fatigue of those who are sensitive in the organ of hearing or in the membranes of the brain. But if the journey is prolonged, that which first excites pain and irritation may in the end cause faintness and exhaustion in weakly persons; and this may be followed by feverish reaction, lasting for some days. I know of some invalids who thus suffer so much from railway travelling that they therefore prefer to submit to the delay and inconvenience of posting.

"Now, as before hinted, on these points railway carriages admit of much improvement; but, until this is effected, I would suggest extemporaneous means of mitigating the motion and noise by means of air-cushions. A small horseshoe air-cushion around the neck of the traveller, and another of larger size around the loins, wonderfully intercept the noise and jarring motion of the carriages. All the motion and the worst of the noise are communicated through the solid walls of the carriages, and the head and back, leaning on them, feel the din and movement in proportion as they are imperfectly cushioned. Now the air-cushion muffles the vibrations more completely than any stuffing; and provided it be not too tightly distended, it isolates from much of the surrounding jar the part resting on it. An invalid thus *air-collared* and *air-girt*, with the legs on an easy foot-rest, and a pillow or cushion or two, if needed, to prop up against the rolling or lateral motion, may generally travel in a first-class carriage with more ease than in the special invalid beds. The noise might be further excluded by stuffing the ears with cotton-wool, but this causes a sensation disagreeable to some persons.

"Some individuals suffer from vertigo, faintness, and nausea on riding backwards in any close carriage, and this effect is commonly greater with the increased speed of the train. I incline to think that this is caused by some disorder of the cerebral circulation, in a manner similar to sea-sickness. The backward motion promotes the afflux of blood to the anterior lobes of the brain, with a corresponding privation of it in the cerebellum and medulla, and disturbance of the functions of the trisplanchnic and associated nerves. Change of position is the obvious corrective of this evil —riding forwards, with a current of fresh air on the face and forehead being the most effectual; but reclining on the side or back may also answer.

"The motion and noise of railway carriages interfere more or less with the free exercise of the senses of sight and hearing. The attempt to read in a shaky carriage, especially small print, or any print, with an imperfect light, is trying to both eyes and head; and those with weak sight or liable to headache should not attempt it. So, also, the effort to carry on a conversation in a noisy carriage is irksome to both hearer and speaker, except in the case of certain deaf persons, who hear better in the midst of noise than usually."

In cases of diseases of the heart, it would seem that the hurry and anxiety attendant on "catching the train," is highly objectionable. Too great caution cannot be exercised in this respect by persons suffering from such maladies.

All congestive and inflammatory affections of the brain and spinal cord, and their membranes, are likely to be aggravated by railway travelling.

Dyspepsia is not an uncommon complaint among habitual travellers, particularly with those who hurry over their breakfasts to be in time for the train, and who have to work particularly hard during the day, that they may be at the station in the afternoon in time to get down to the country to a heavy late dinner.

The influence on the liver, on the production of diseases of the abdominal viscera, as well as many other phases of this important subject, are discussed in the papers before us, which are well worth the attention of all who travel by railway, that is, of everyone.

The secondary effects of injuries resulting from railway accidents, and, among them, of many which did not at the time of their occurrence present any indications of being of any great importance, are shown, from the evidence furnished at the trials, no less than from the verdicts obtained by the sufferers against the Railway Companies, to be frequently of a most serious character.

The public may learn, from the details of these cases, the necessity of not being too ready to compromise with the Companies their claims for injuries incurred by such accidents, the secondary effects arising frequently at periods extremely remote from the date of the accident.

The following extract will show the importance to the public of correct information on this subject:—

"It would appear, from the evidence on various trials which have been instituted to recover compensation from railway companies, that neither the direct shocks produced by the accident, nor the physical injury inflicted at the time, afford any trustworthy indication of those insidious results which may subsequently ensue at a more or less distant period. That these are chiefly due to the violent concussion of the nervous centres experienced during the shock, is clearly shown by the character of the symptoms presented; tingling and numbness of the extremities, local paralysis, paraplegia, functional lesions of the kidneys and bladder; and sometimes those slowlyensuing symptoms of intellectual derangement long since observed to occur in certain cases of severe cerebral concussion. Symptoms such as these, slowly and insidiously coming on, have especially attracted notice by their frequent occurrence after severe railway accidents. The vehemence and suddenness of the jolts experienced during a collision exceed in violence any other kind of shock to which human beings are exposed in travelling. The cases hitherto recorded seem to indicate that heavy and robust persons, as might be anticipated, are especially liable to suffer in the way here described. And there is reason to suspect that in many cases the subsequent occurrence of severe symptoms may be traced to carelessness. Persons escape the immediate danger, and, believing that they are uninjured beyond the severe mental impression of fright, go on their way rejoicing, and neglect the necessary precaution of affording that long period of perfect rest to the brain and spinal column which may enable them to recover from the shock. It is interesting to remark, that the effects which slowly ensue in a previously healthy person after such a violent concussion, resemble in a more intense degree those symptoms distinctly traced, in cases already related, to the recurring small concussions experienced during prolonged railway travelling.

"No precise limit has yet been fixed beyond which the law refuses to admit that actions for damages may be sustained, although this point has been several times mooted in court. These public trials, however, represent but a very small proportion of the cases in which compensation is paid by the railway companies, and the matter is kept as much as possible from public notice. In the year 1860, the enormous sum of £181,270 was paid as compensation for damages sustained by railway accidents."

Notwithstanding the large sums frequently recovered by sufferers in these terrible accidents, unfortunately of very frequent occurrence, and which seem for the most part to be the result of culpable, not to say criminal, neglect on the part of those to whom the safety of the public is confided, a pecuniary award is, in fact, no compensation to the widow and orphan for the loss of the husband and father, nor, in case of bodily injuries, can the value of broken limbs and shattered constitutions be measured by a money standard.

Of greater value, accordingly, do all suggestions become for the prevention of these lamentable calamities, with the details of which the newspapers so often sicken us.

The *Lancet* Commissioners have not failed to draw their own practical inferences from the evidence that has passed through their hands, and they have been naturally led, by a consideration of it, to make several valuable suggestions for the safety, health, and comfort of railway passengers.

Let us hope that now the attention of the public has been called to this subject, by the valuable papers we have been considering—papers which are both essentially practical and within the comprehension of the ordinary reader, and published, moreover, at a mere nominal price—the public, who are so vitally interested in the question, may insist on some more stringent means being adopted by the Government for the regulation of those wealthy monopolists, the Railway Companies of the kingdom. When we consider that 163 millions of lives are annually entrusted to their charge, it is not unreasonable to demand that the very strictest regulations that experience may suggest as necessary, should be enforced upon the Companies by the Legislature, to provide duly for the safety of the travelling public, who have no resource but to avail themselves of the only method of locomotion now open to them.

The Reports of the Government Inspectors, quoted by the Commissioners, show most clearly that some additional legislation is necessary, seeing the number of those accidents that those gentlemen report as being due to laxity of discipline on the lines—to the unsafe methods adopted for conducting the traffic—and to the opposition to suggestions for the remedy of existing abuses.

With reference to the long-pointed-out dangers, for example, attendant on the want of communication between the engine-driver and guard, it seems almost marvellous, considering the number of fatal accidents that have been shown to have occurred from this want, a want which has been so many times pointed out, and which is so peculiarly easy of remedy, that no steps should, up to this period, have been taken on the part of the public to insist on so simple a precaution being taken.

A few extracts from recent official reports made by the Government Inspectors to the Board of Trade, will show the truth of the foregoing remarks.

"*May* 30*th*, 1860.—The suggestions of the inspecting officers, and their lordships' urgent representations on the subject, though repeatedly made, are thrown aside as entirely impracticable."

"*Nov.* 19*th*, 1860.—Looking to the frequency of boiler explosions, it becomes a question for serious consideration whether it is not desirable that precautions should be enforced by law. If such precautions were properly enforced, these explosions would be as rare as they are now frequent."

"*Jan.* 18*th*, 1861.—Had the passengers had any means of communication with the guard in the van in front of their carriage, when they first became aware that something was wrong, they need not have been carried for miles under such circumstances of extreme peril. But it seems hopeless to expect that Railway Companies will do anything in this matter unless the Legislature compels them to do so. I am afraid it is hopeless to expect any improvement, and I know that it is useless for an inspecting officer to continue to call attention to it."

"*Feb.* 21*st*, 1861.—If warning were taken from accidents of this kind occurring, not only on one, but on most of the railways in England, improvements might be introduced similar to those which have on some lines been adopted; but with the studied persistence in such a vicious system, the reports of the inspecting officers might almost as well not be made, as they appear to serve no other useful purpose than to give the sufferers in railway accidents, or their representatives, a clue on which to base their demands for compensation."

"*April 4th*, 1861.—The collision was undoubtedly the almost inevitable result of the vicious system of working, by which one train is allowed, in defiance of the Company's printed regulations, to follow another at a distance of from 60 or 70 to 200 or 300 yards, and by the entire want of discipline maintained on the line, by which an engine-driver is permitted to disregard danger-signals with impunity. If such regulations are allowed to be broken, and remain unpunished when no accident occurs, as in the 99 cases out of the 100, they should not be appealed to in the 100th when some mishap takes place."

"*Sept. 21st*, 1861.—I am bound to say that rules, which are violated every day in the working of a railway, should be revised, as it is useless to appeal to rules when the practice is all against them."

Among the more fertile causes of danger in connexion with railway travelling may be mentioned, the long hours during which the railway *employés* are kept continuously at work—the want of signal communication between the guard and driver—the defective construction of the wheels of the carriages—the inefficient and irregular system of signals—the want of adequate break power—and the want of punctuality in the starting and arrival of trains—almost every one of these being capable of instant and tolerably easy remedy.

As regards the wheels, the following remarks are important:—

"*Accidents from Wheels.*

"A second most important cause of peril to life and limb through railway accidents is the defective construction of wheels. This has been again and again urged by Government inspectors when tires flying off have led to serious mischief; yet the companies pay little or no attention. Remedies for the evil there are many, and no less than seven for which patents have been obtained. Each of these new wheels is of such construction that the tire cannot well fly off suddenly; and the best of them has been adopted in the recently-constructed royal carriage. This wheel was, we believe, invented more than 20 years ago; and its merits are just now recognized, when the safety of the Queen demands extra caution. For it appears that the railway companies have hit on a plan for avoiding alterations, equally discreditable and ingenious. They are willing—so runs the argument—to adopt any efficient plans, but just wait until some perfect one is devised; and, as there is no wheel-trade yet established with Utopia, life is still constantly endangered by the old arrangements. And here we come to another curiosity of railway management, little known to the public. The inventor of any patented article usually obtains reward for his ingenuity by a royalty on the sale from persons making use of his discovery. A number of ingenious improvements adapted solely for use by railway companies are yearly patented, and the system pursued towards the inventors is that, after approval of the plan suggested, it is determined to wait until the time of the patent expires before adopting it. Thus the old stock is used up, and the royalty to the patentee saved; and, though a few more preventable accidents may occur, yet the public are supposed to be used to being so treated, and the only anxiety is to keep the reports out of the papers, or to soften them as much as possible; hence the regular official letter which appears in the papers after such an accident, explaining that no one could possibly be to blame, and that the board are deeply grieved, &c."

It is important to bear in mind that, by due regard to the earlier premonitory symptoms of mischief—which, thanks to the laborious investigation undertaken at the instigation of the editors of the *Lancet,* with a view to the good of the public, we now have the opportunity of detecting for ourselves—we need have less reason to fear any very serious results from the present inevitable system of locomotion.

"There are only two classes of persons especially likely to be injuriously affected by moderate railway journeys, even though frequent: they are persons advanced in life and of weakened power, and those who are subject to the special diseases which have already been studied in this relation. The actual exertion, the excitement, the mental strain, the peculiar influences of the motion of a railway carriage, indicate its dangers to those first mentioned. These constitute a small minority. But there are a number of persons who, although not far advanced in age, are yet the subjects of various conditions of ill health depending on insidious degenerative diseases of the brain and heart. The season-ticket holders of the railways are, in large numbers, men who have passed the best years of their life in hard and exhausting employment of mind and body. They are the successful merchants; the senior partners of flourishing firms, which they have built up by a life of labour; half-retired tradesmen; half-invalid bankers; *et id genus omne.* We can now see that it is by the injuries which have resulted to these men from their constant travelling to and from town that an impression has become current as to certain mischiefs which habitual travelling inflicts. When it was known that such a banker, who comes up fifty miles three or four times a week, has to lie down half-an-hour before he can sign a cheque; that such a well-known chemist has suffered from symptoms of brain excitement since he bought his new house by the sea and travelled daily to London; or that a certain barrister has found himself obliged to pay for his journey by epileptic seizures, the alarm soon extended beyond reasonable limits. But few men can endure without suffering to travel fifty or a hundred miles daily to their business for any length of time. The influence of the journey itself is heightened by many accessory conditions to which we have adverted; and the present construction of the rails and carriages is such as to deprive the traveller of all those mitigations by which his discomfort might be diminished and his health safe-guarded.

" *Catching the Train.*

" Amongst the unprecedented collection of cases brought under our notice during this inquiry, there have been recorded several of serious mischief, and even death, from persons in ill health hurrying to catch trains, and sitting down, heated and breathless, in the draught caused by the moving of the train which they have just managed to be in time for. It is almost exclusively at large termini that these cases have occurred, and that the cause of them obtains. Now, this rushing in at the last moment, we are informed, is becoming more frequent; and consideration of the condition in life of those who constitute the majority of season-ticket holders would indicate how this evil arises. We believe it would be advantageous to public health and safety, however harsh it may at first appear, that the doors at termini should be closed five minutes previous to the departure of each train, so that sufficient time should be allowed for passengers to quietly settle themselves, and also for the officials, who are often (as one of them graphically expressed it) " torn to pieces" just at the last moment. It is well known that the difficulties with luggage, which this arrangement would obviate, are frequently causes of delay in starting trains. Then there is high speed to make up lost time or want of punctuality, both of them fraught with danger to passengers.

" *Cautions to Habitual Travellers.*

" It has been shown that the injurious effects which habitual railway travelling produces on some who escape such influences when only taking occasional journeys are very marked. In such persons, heedless continuance comes to be a cause of disease. In some, there have been no previous symptoms that they could recognize, or such as would have deterred them from undertaking the daily journey; and thus the season-ticket is taken, and has soon to be disused, or the health suffers. In all cases the evidence points to the conclusion that the injurious influence slowly and gradually increases whilst the cause remains—that tolerance is not established by persistence.

" It is too much the custom, when adopting a country residence on a railway line, to make no new arrangements of business according to the diminished time for work which the daily interval between the morning and evening trains allows. Hence that hurry, anxiety, and working of the brain at high pressure, which of all things tend to develop in susceptible persons such injurious effects on health as habitual railway travellers often experience. The remedy for this is obvious: " Cut your coat according to your cloth"—" Mene tenus propriâ vive"—" Selon le pain il faut le couteau"—are saws proved to be wise. But we believe that no person is justified in undertaking a series of continuous journeys by rail under the conditions alluded to (if under any circumstances) without previously consulting his medical attendant as to their probable effect on his health, the precautions he should adopt, and the warning symptoms which he may not safely disregard."

Since the *Lancet* commission was undertaken, railway travelling has assumed a new aspect, in the opening of the Metropolitan underground railway.

In addition to the several causes already discussed, which tend to modify the health of railway travellers, we shall now have the additional evils to contend against of want of light and pure air—wants which will not be unlikely to tell upon the health of habitual travellers, and which, most assuredly, will act injuriously on those whose duties keep them all day in the dark, close, underground tunnels, impregnated with carbonic acid gas, given off from the lungs of the thousands of passengers, and which, from its high specific gravity will not be easily driven out of ill-ventilated underground passages—with sulphurous acid gas, a gas of even higher specific gravity than carbonic acid, produced by the combustion of the coke, often of very inferior quality, used in the engines on this line instead of coal, with the view to the production of as little smoke as possible, and, perhaps, even with nephitic exhalations from the sewers and gas-sodden earth through which the line passes.

That this is no imaginary evil, is proved from the fact that, on the second day of the public opening of the line, the air became so vitiated at one of the stations that the signal-men and others on duty became, one by one, actually asphyxiated—whether by carbonic acid or sulphurous acid, or by some emanations from the ground, does not clearly appear. At all events, several men had to be removed to the hospital, and it was only by procuring fresh relays of men that the traffic could be carried on at all.

Of course, steps will be taken to remedy, as much as possible, all unexpected difficulties of this character, by the introduction of some more efficient system of ventilation, and by other means which will, no doubt, be suggested for the purpose.

It will still continue a question of grave doubt, however, whether a confined underground tunnel can be at all times kept sufficiently well supplied with oxygen to meet the sanitary requirements of those who have to pass many hours daily in it.

The carriages moreover, on this railway, will naturally be peculiarly liable to become impregnated with impurities from the breath and bodily exhalations of the constant succession of persons who travel in them; and it will be probably far less easy to ventilate the carriages than the tunnel itself.

The experiments of Dr. R. Angus Smith, as to the condition of the air in railway carriages, show decisively how objectionable even the carriages on ordinary lines of railway become, even running as they do at very high speed through the pure country air. How much more, therefore, evils of this kind will be increased in the underground lines it will not be difficult to predicate.

The following extract will show the result of Dr. Smith's investigations into this subject:—

"The air of several places being examined by the method described in my papers, I have found that a given amount of the permanganate solution is decomposed by different volumes of air, according to its state of purity. The numbers here given represent the volume of air capable of decomposing an amount of the solution of the permanganate, the same in every case. They represent, therefore, the proportionate purity of the air; the highest numbers represent the purest air.

"*Cubic inches of air requisite for the decomposition of a given amount of solution, showing comparative amounts of oxidizable matter.*

MANCHESTER.

	Cubic inches.
Air at All Saints', inside my laboratory	72,000
Front of the house	74,000 to 76,000
Bedroom looking to the back	64,000
Same room in the morning after being slept in	56,000
Bank of the Medlock, behind dirty houses	44,000
High grounds, thirty miles north of Manchester	176,000 to 209,000
Closely-packed railway carriage	8,000
When the strong smell of a sewer entered my laboratory	8,000

"Thus a railway carriage closely packed stands very low in the scale. I may mention that the carriage examined was a third-class one. In very hot weather the woollen coverings of a first-class carriage are hurtful, but I do not think them so in cool or in ordinary weather, if kept clean; on the contrary, I think them beneficial. A good deal of the impurity is retained by the wool, and is not given off, but is oxidized in its place. A high temperature sends off some without oxidation, and produces what is called a choking sensation. When the sides are impervious to moisture, as in the second and third classes, there are great risings and fallings in the purity of the air. The impurity is then neither retained by the surface until oxidation takes place, nor slowly and gradually given out, but evaporates with great rapidity.

"These remarks apply especially to cases in which warmth and cold, moisture and dryness, alternate. In constant warmth the impurity is not retained; in constant cold it is not given out. When cold or moist it is retained, and given out again when dry or warm.

"Similar remarks apply to carpeted and uncarpeted rooms. Carpets are incapable of causing any discomfort if perfectly clean, and even tend to purify the air; but when not clean, they cause an unpleasant sensation, which increases with the temperature to a certain point. The more impurity there is the less will wool and similar substances bear an elevation of temperature, unless the elevation be constant, when the wool seizes very little of the impure matter. With care and cleanliness, the linings of railway carriages may last pure till the cloth is worn out, and they do so in some places; but in some counties (and it seems to me that Lanchashire is one of the worst) there is no regard to the property of the Company or the comfort of those coming after; dirty boots are put on the cushions, and the carpets are fouled by expectoration. This is at first less felt in first-class carriages; but as it cannot on the present arrangements be conveniently washed out, it accumulates. This is probably the reason why our first-class carriages are made so much less comfortable than those on the Continent. It would be greatly to their advantage if they were disinfected occasionally. The most easy way would be to take out the cushion portion, raise it to the temperature of about 180° Fahr. or more, first with steam, then with dry air, and then beat and brush thoroughly.

"The atmosphere of railway carriages is only apt to be hurtful from bad ventilation when crowded, because of the frequent opening of doors and the almost impossibility of keeping out the air. At the same time, it depends upon the state of the weather—the temperature of the wind chiefly. When temperature rises, all impure surfaces become more offensive, and everything known has a smell—persons and animals pre-eminently. We can readily smell the inmates of a carriage for a considerable time after they have left, if the carriage has been crowded. But I know of no rule whatever as to the preservation of temperature or amount of air. The person who comes rapidly to the station wants fresh air; and he who has been sitting for hours desires warm air. Nature tells each his requirement. The person weary with sitting, and with his blood slowly circulating, does not require so much air; if you give him as much as the person fresh and flushed, he cannot resist the lowering of the temperature, and becomes feverish, irritated, or chilled. Inferior air is better to him than loss of heat. And why? The heat of the system must be maintained, no matter what else is diminished; because every function depends on it. No wonder that persons, to avoid cold, breathe the impure air. Life may exist in pest-houses for years, and may continue through a raging fever for weeks; but to be cooled down to a certain easily-reached point, puts us in a few minutes beyond all help, and a draught may bring death like a bullet.

"It would be a great point gained if carriages could be ventilated without a violent draught, laden with dust, in the face of some one who is supposed to be insensible to good air, because he is sensitive to cold; he knows that he may very soon recover from the effects of any bad air generally caused by crowding in carriages, but from the cold he knows with no certainty when.

"One of the evils of railway travelling in warm weather is the dust. The amount, especially at some distance from the engine, is sometimes more difficult to bear than the confinement of the air; and I think it must at times be more hurtful than the work of the stonemason, beside whom I have frequently stood, feeling far less dust than on a railway on a fine summer day; and yet we know the mason suffers.

"If the carriage is constantly ventilated moderately, no time is allowed for the wool to absorb the vapours from the breath and skin; but if the carriage is sometimes filled with unpleasant exhalations for a considerable period, it may require a still longer time of the action of pure air to cause their removal and destruction. Mere change of air in the carriage is not sufficient. We may smell the air of a crowded building on persons who have left it many minutes—I can from experience mention twenty minutes, and I have no unusually acute sense of smell."

The difficulty of effecting a perfect combustion of the smoke of furnaces is known to be very great. The use of coke instead of coal, with the view to diminish the quantity of smoke produced, is attended with an almost certain generation of sulphurous acid gas, large or small in amount, in proportion to the purity of the coke employed.

What with smoke, sulphurous acid, steam, carbonic acid, escaped hydrogen—with which gas the carriages on this line are lighted—and, possibly, even noxious air from sewer, and other underground emanations, a most perfect system of ventilation will be indispensably requisite in these subterranean lines of railway; and we know well how great a desideratum a good system of ventilation has always been found to be, even when expense is no object, as in the instance of the new Houses of Parliament.

Complaints from the engine-drivers on the Metropolitan Railway, of pains in the head, caused, no doubt, by the vitiated atmosphere, have already reached the public ear.

On a line like this, where so much depends upon the care exercised by the engine-drivers, signal-men, and others—all of whom, it should be remembered, have to carry on their duties almost in darkness—it would be a most prolific source of danger for these men to be liable to become insensible, or even to be deprived of the full use of their mental faculties during the performance of their duties.

But supposing lines of underground railway to be perfectly free from all injurious products of combustion and other impurities, and supposing that the want of daylight exerted no injurious influence on those deprived of it for the greater part of each day, the mere fact of such schemes being successful will, undoubtedly, give rise to the construction of similar lines, so that the number of habitual railway travellers, exposed, let us say, only to the risks and evils referred to in the *Lancet* papers, will be increased by several millions of persons in the course of the year, and the risk, accordingly, of accidents and of injury to health will, of course, be proportionally increased, and hence the more immediate necessity for some additional Government interference, with the view to the protection of the lives, persons, and health of the travelling public.

The writer of this article trusts, that the importance of the subject, in which so large a proportion of the community are so vitally interested, will be considered a sufficient excuse for the length to which his remarks have been allowed to extend, and that the anxiety he ventures to express on the subject may be participated in by the public to a sufficient extent to cause some exertion to be made for the furtherance of the desired end.